# CHAPTER 3

*Problems and Questions*

1. The following table lists the stock prices for Microsoft from 1989 to 1998. The company did not pay any dividends during the period

| Year | Price |
|---|---|
| 1989 | $ 1.20 |
| 1990 | $ 2.09 |
| 1991 | $ 4.64 |
| 1992 | $ 5.34 |
| 1993 | $ 5.05 |
| 1994 | $ 7.64 |
| 1995 | $ 10.97 |
| 1996 | $ 20.66 |
| 1997 | $ 32.31 |
| 1998 | $ 69.34 |

a. Estimate the average annual return you would have made on your investment

b. Estimate the standard deviation and variance in annual returns

c. If you were investing in Microsoft today, would you expect the historical standard deviations and variances to continue to hold? Why or why not?

2. Unicom is a regulated utility serving Northern Illinois. The following table lists the stock prices and dividends on Unicom from 1989 to 1998.

| Year | Price | Dividends |
|---|---|---|
| 1989 | $ 36.10 | $ 3.00 |
| 1990 | $ 33.60 | $ 3.00 |
| 1991 | $ 37.80 | $ 3.00 |
| 1992 | $ 30.90 | $ 2.30 |
| 1993 | $ 26.80 | $ 1.60 |
| 1994 | $ 24.80 | $ 1.60 |
| 1995 | $ 31.60 | $ 1.60 |
| 1996 | $ 28.50 | $ 1.60 |
| 1997 | $ 24.25 | $ 1.60 |
| 1998 | $ 35.60 | $ 1.60 |

a. Estimate the average annual return you would have made on your investment

b. Estimate the standard deviation and variance in annual returns

c. If you were investing in Unicom today, would you expect the historical standard deviations and variances to continue to hold? Why or why not?

3. The following table summarizes the annual returns you would have made on two companies – Scientific Atlanta, a satellite and data equipment manufacturer, and AT&T, the telecomm giant, from 1988 to 1998.

| *Year* | *Scientific Atltanta* | *AT&T* |
|---|---|---|
| 1989 | 80.95% | 58.26% |
| 1990 | -47.37% | -33.79% |
| 1991 | 31% | 29.88% |
| 1992 | 132.44% | 30.35% |
| 1993 | 32.02% | 2.94% |
| 1994 | 25.37% | -4.29% |
| 1995 | -28.57% | 28.86% |
| 1996 | 0.00% | -6.36% |
| 1997 | 11.67% | 48.64% |
| 1998 | 36.19% | 23.55% |

a. Estimate the average and standard deviation in annual returns in each company

b. Estimate the covariance and correlation in returns between the two companies

c. Estimate the variance of a portfolio composed, in equal parts, of the two investments

4. You are in a world where there are only two assets, gold and stocks. You are interested in investing your money in one, the other or both assets. Consequently you collect the following data on the returns on the two assets over the last six years.

| | Gold | Stock Market |
|---|---|---|
| Average return | 8% | 20% |
| Standard deviation | 25% | 22% |
| Correlation | -.4 | |

a. If you were constrained to pick just one, which one would you choose?

b. A friend argues that this is wrong. He says that you are ignoring the big payoffs that you can get on gold. How would you go about alleviating his concern?

c. How would a portfolio composed of equal proportions in gold and stocks do in terms of mean and variance?

d. You now learn that GPEC (a cartel of gold-producing countries) is going to vary the amount of gold it produces with stock prices in the US. (GPEC will produce less gold when stock markets are up and more when it is down.) What effect will this have on your portfolios? Explain.

5. You are interested in creating a portfolio of two stocks – Coca Cola and Texas Utilities. Over the last decade, an investment in Coca Cola stock would have earned an average annual return of 25%, with a standard deviation in returns of 36%. An investment in Texas Utilities stock would have earned an average annual return of 12%, with a standard deviation of 22%. The correlation in returns across the two stocks is 0.28.

a. Assuming that the average and standard deviation, estimated using past returns, will continue to hold in the future, estimate the average returns and standard deviation of a portfolio composed 60% of Coca Cola and 40% of Texas Utilities stock.

b. Estimate the minimum variance portfolio.

c. Now assume that Coca Cola's international diversification will reduce the correlation to 0.20, while increasing Coca Cola's standard deviation in returns to 45%. Assuming all of the other numbers remain unchanged, answer (a) and (b).

6. Assume that you have half your money invested in Times Mirror, the media company, and the other half invested in Unilever, the consumer product giant. The expected returns and standard deviations on the two investments are summarized below:

| | Times Mirror | Unilever |
|---|---|---|
| Expected Return | 14% | 18% |
| Standard Deviation | 25% | 40% |

Estimate the variance of the portfolio as a function of the correlation coefficient (Start with –1 and increase the correlation to +1 in 0.2 increments).

7. You have been asked to analyze the standard deviation of a portfolio composed of the following three assets:

| Investment | Expected Return | Standard Deviation |
|---|---|---|
| Sony Corporation | 11% | 23% |
| Tesoro Petroleum | 9% | 27% |
| Storage Technology | 16% | 50% |

You have also been provided with the correlations across these three investments:

| | Sony | Tesoro | Storage Tech |
|---|---|---|---|
| Sony | 1.00 | -0.15 | 0.20 |
| Tesoro | -0.15 | 1.00 | -0.25 |

Storage Tech 0.20 -0.25 1.00

Estimate the variance of a portfolio, equally weighted across all three assets.

8. You have been asked to estimate a Markowitz portfolio across a universe of 1250 assets.

a. How many expected returns and variances would you need to compute?

b. How many covariances would you need to compute to obtain Markowitz portfolios?

9. Assume that the average variance of return for an individual security is 50 and that the average covariance is 10. What is the expected variance of a portfolio of 5, 10, 20, 50 and 100 securities. How many securities need to be held before the risk of a portfolio is only 10% more than the minimum?

10. Assume you have all your wealth (a million dollars) invested in the Vanguard 500 index fund, and that you expect to earn an annual return of 12%, with a standard deviation in returns of 25%. Since you have become more risk averse, you decide to shift $ 200,000 from the Vanguard 500 index fund to treasury bills. The T.bill rate is 5%. Estimate the expected return and standard deviation of your new portfolio.

11. Every investor in the capital asset pricing model owns a combination of the market portfolio and a riskless asset. Assume that the standard deviation of the market portfolio is 30%, and that the expected return on the portfolio is 15%. What proportion of the following investor's wealth would you suggest investing in the market portfolio and what proportion in the riskless asset? (The riskless asset has an expected return of 5%)

a. an investor who desires a portfolio with no standard deviation

b. an investor who desires a portfolio with a standard deviation of 15%

c. an investor who desires a portfolio with a standard deviation of 30%

d. an investor who desires a portfolio with a standard deviation of 45%

e. an investor who desires a portfolio with an expected return of 12%

12. The following table lists returns on the market portfolio and on Microsoft, each year from 1989 to 1998.

| *Year* | *Microsoft* | *Market Portfolio* |
|---|---|---|
| 1989 | 80.95% | 31.49% |
| 1990 | -47.37% | -3.17% |

| | | |
|---|---|---|
| 1991 | 31% | 30.57% |
| 1992 | 132.44% | 7.58% |
| 1993 | 32.02% | 10.36% |
| 1994 | 25.37% | 2.55% |
| 1995 | -28.57% | 37.57% |
| 1996 | 0.00% | 22.68% |
| 1997 | 11.67% | 33.10% |
| 1998 | 36.19% | 28.32% |

a. Estimate the covariance in returns between Microsoft and the market portfolio

b. Estimate the variances in returns on both investments

c. Estimate the beta for Microsoft

13. United Airlines has a beta of 1.50. The standard deviation in the market portfolio is 22% and United Airlines has a standard deviation of 66%

a. Estimate the correlation between United Airlines and the market portfolio.

b. What proportion of United Airlines' risk is market risk?

14. You are using the arbitrage pricing model to estimate the expected return on Bethlehem Steel, and have derived the following estimates for the factor betas and risk premia:

| Factor | Beta | Risk Premia |
|---|---|---|
| 1 | 1.2 | 2.5% |
| 2 | 0.6 | 1.5% |
| 3 | 1.5 | 1.0% |
| 4 | 2.2 | 0.8% |
| 5 | 0.5 | 1.2% |

a. Which risk factor is Bethlehem Steel most exposed to? Is there any way, within the arbitrage pricing model, to identify the risk factor?

b. If the riskfree rate is 5%, estimate the expected return on Bethlehem Steel

c. Now assume that the beta in the capital asset pricing model for Bethlehem Steel is 1.1, and that the risk premium for the market portfolio is 5%. Estimate the expected return, using the CAPM.

d. Why are the expected returns different using the two models?

15. You are using the multi-factor model to estimate the expected return on Emerson Electric, and have derived the following estimates for the factor betas and risk premia:

| *Macro-economic Factor* | *Measure* | *Beta* | *Risk Premia ($R_{factor}$-$R_f$)* |
|---|---|---|---|
| Level of Interest rates | T.bond rate | 0.5 | 1.8% |
| Term Structure | T.bond rate – T.bill rate | 1.4 | 0.6% |
| Inflation rate | CPI | 1.2 | 1.5% |
| Economic Growth | GNP Growth rate | 1.8 | 4.2% |

With a riskless rate of 6%, estimate the expected return on Emerson Electric.

16. The following equation is reproduced from the study by Fama and French of returns between 1963 and 1990.

$$R_t = .0177 \quad - 0.11 \ln (MV) + 0.35 \ln (BV/MV)$$

where MV is the market value of equity in hundreds of millions of dollar and BV is the book value of equity in hundreds of millions of dollars. The return is a monthly return.

a. Estimate the expected annual return on Lucent Technologies. The market value of equity is $ 180 billion, and the book value of equity is $ 73.5 billion.

b. Lucent Technologies has a beta of 1.55. If the riskless rate is 6%, and the risk premium for the market portfolio is 5.5%, estimate the expected return.

c. Why are the expected returns different under the two approaches?